UNPUBLISHED PRELIMINARY DATA

QUARTERLY STATUS REPORT No. 1

Period 23 September 1964 - 22 December 1964

DESIGN, DEVELOPMENT, FABRICATION AND INSTALLATION OF 84-INCH LUNAR AND PLANETARY TELESCOPE AT McDONALD OBSERVATORY

Contract NASr-242

Project Director: Harlan J. Smith
Director, McDonald Observatory

Department of Astronomy, The University of Texas

Austin, Texas

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Contract NASr-242

In its initial form, at the beginning of this Status Report Period, Contract NASr-242 specified that The University of Texas shall construct an 84-inch telescope suitable for planetary as well as other astronomical re-research, with appropriate auxiliary instruments, and that The University of Texas shall provide the dome and any associated building.

A. Selection of Designer

Even by the high standards of many modern machines, large telescopes present unusually stringent design and performance requirements. A complete successful telescope design requires optimum compromise between, and effective solution of, a number of interacting and often conflicting requirements. For this reason, an engineering firm with skill and experience in telescope design is desirable, perhaps necessary, if speed of execution is also a primary concern as in the present case.

Also, if competitive bidding is to enter into the selection of a firm for construction of the telescope, it is necessary to have a reasonably complete initial design against which all firms can bid. In this way, it becomes more possible to make a fair comparison between and choice among the competing firms.

Finally, it is extremely important for the astronomers who will use the telescope to provide their input at the very beginning of design, when their experience with existing telescopes and their desires for the new one can still be made a part of the new instrument without forcing excessively difficult, costly and oten unsatisfactory changes on a completed or partially completed design.

With the above factors in mind, immediately upon the signing of the contract, serious negotiations were entered into with three of the firms that had expressed strong interest in being considered for design of the telescope, discussions with these firms having begun as far back as July 1964. Of the three, Western Gear was not able to substantiate design experience and performance relevant to large telescopes. Westinghouse (Sunnyvale) could substantiate ability and experience, although again not proved performance of any Westinghouse telescope design (although within several years this will become possible).

Charles W. Jones Engineering was selected on five principal grounds:

1. Jones himself has had outstanding training (Cal Tech engineering) and experience (many years in designing some of the largest moving machinery in use in the world today — shovels, dredges, trucks, etc.).

2. Jones has had more experience in the engineering design of large telescopes than any commercial engineer in this country, having been connected in one capacity or another, including in several cases primary design responsibility, for essentially all of the large telescopes built in the United States since the Lick 120-inch, as well as for several of the large radio telescope designs.

3. Jones is recommended by each of the astronomical groups with which he has worked.

4. Jones has the best record of performance with large telescopes; most specifically, the 61-inch Naval Observatory reflector is probably the only major telescope of recent construction to have been completed within the time and budget estimates of its engineering, and Jones was completely responsible for this engineering and for the basic overseeing of the execution of this project.

5. The Jones firm was relatively open for new work at the time of negotiation, and was thereby able to guarantee rapid development of the design.

In November The University of Texas Regents and the NASA Contract Office agreed on the selection of Jones; also, in view of the need for speed, that he should begin work to deliver a satisfactory bidable telescope design at the earliest opportunity (approximately May 1965) on a fixed fee basis for all work performed on this design project, but with a design-cost ceiling of $120,000.

B. Provisional Design Parameters

Upon first learning of the project in the summer of 1964, Jones became interested in the possibility of doing the design, and prepared basic layouts of several possible configurations for the new telescope. Accordingly, when it was decided that Jones would in fact be the designer, it was possible without delay to take up serious consideration of various possibilities for the basic configuration.

In addition to the McDonald Observatory Director, the Austin astronomy group primarily responsible for design selection included Professors de Vaucouleurs and Tull, J. Texereau (consultant with us for nine months from the staff of the Paris and Haute Provence Observatories in France), and J. Floyd (our principal design engineer in the Astronomy Department at Austin. Several discussions of the design were also held in person or by telephone with Drs. Morgan and Hiltner at Yerkes, Mayall and Meinel at

Tucson, and Whitford at Lick Observatory. Two all-day conferences were also arranged with Drs. Bowen and Babcock, and Bruce Rule, at Cal Tech and the Mount Wilson Observatory.

It was clear from the beginning that for this telescope we should not seek an exotic design which would involve radical departures from previously proved large telescope design, engineering, and operational techniques. While such departures could undoubtedly be designed, and might well be successful, we would be running the near certainty of long-time requirements in developing them and in working out the bugs, also a real risk of serious failure. Accordingly, an early decision was made to be "conventional".

In this case, conventionality can be interpreted as a fork mounting or a cross-axis mounting, since either is known to be completely successful in designs of the order of 100-inch (for sizes far above 100-inch, it appears necessary to go to some form of large flotation horseshoe bearing, and for sizes much above 200-inch, it may be necessary to turn to alt-azimuth mountings).

Two schools of thought quickly became apparent on the choice between fork and cross-axis mountings. The Mount Wilson and Cal Tech group unanimously favored the fork designs, which they have pioneered and used successfully over the last 20 or 30 years (or indeed 60 years, considering the 60-inch at Mount Wilson). Forks have advantages which include symmetry of mounting, centering in the dome, non-ambiguous positional read-outs, least motion of Cassegrain focus, and (perhaps) greatest safety of operation.

On the other hand, with perhaps the sole exception of Dr. Babcock, the astronomers who have used the McDonald 82-inch telescope and the recent Grubb-Parsons cross-axis instruments such as the Haute-Provence 76-inch, favored retaining the McDonald 82-inch cross-axis design. The principal arguments in favor of it are the lack of need for an enormous horseshoe or circular hydraulic polar bearing with its cost and potential difficulties, the convenience of a completely uncluttered Cassegrain focal position which never has to swing between the tines of a fork and which therefore can be adapted to rather large equipment, the lack of interference by the fork arms in rising floors or platforms, and the simplest possible direct four-mirror coude system. The principal bearing problem with this design, that of the declination axis which must support a very large eccentric load, according to Jones is readily soluble with commercially available bearings for telescopes as large as 105-inch. An additional factor arose when we decided to generate an unusually large coude space for this telescope on the floor under the observing floor, in which case the two-pier cross-axis design offered a slightly more direct mounting tie-in for the spectrograph and less interference with the coude light paths. Finally, it was felt that it would be better to have the two major instruments of the McDonald Observatory of a common basic design, other things being so nearly equal in the choice.

Accordingly, immediately after selection of Jones as design engineer and the meetings outlined above, a firm decision was reached to make the new telescope an enlarged and improved version of the 82-inch cross-axis design.

C. Selection of Size of Telescope

Upon signing of the contract in September, the Project Director at once began looking seriously into possible sources of supply for the required large primary mirror blank. A 105-inch, completely cast and annealed, Duran 50 Pyrex disk fabricated by Schott at Mainz, West Germany, was discovered to be for sale. The prospect of almost immediate delivery of the blank, at only one-third the price of a fused silica blank, led to the investigation of the possibility of making the new telescope 105-inch in size. Accordingly, Jones was asked to carry along parallel initial designs for fork and cross-axis mountings, with 84- and 105-inch primaries, and to come up with a set of estimated prices for these alternatives. No clear cost differential could be established between the fork and cross-axis designs, although it seemed that the cross-axis might be slightly cheaper, depending on the problems encountered in the bearings. It also appeared that the mechanical parts of the new telescope would cost nearly half a million dollars more in the 105-inch than in the 84-inch size.

However, further investigations showed that optically the 105-inch Duran 50 blank would not give the desired performance on three grounds:

1. As a Pyrex mirror, it would take significantly longer to polish in the prolonged stages of final figuring because of its six times greater coefficient of expansion over fused silica, requiring relatively long delays for the blank to cool to equilibrium after being worked; this disadvantage would probably make up in over-all delivery time in the finished blank for the additional time required to fabricate a new fused silica blank.

2. The Pyrex blank as cast by Schott was 24 inches thick. This generates an enormously heavy mirror, and one which is unnecessarily slow to thermal changes. Our experience with the McDonald 82-inch Pyrex mirror shows that approximately two days are required for it to settle back to thermal equilibrium of figure, after passage of a cold front. The larger and much thicker Duran 50 blank would probably require between three and four days — a very unsatisfactory state of affairs, considering that some of the best weather at McDonald follows after the passage of a cold front.

   The best modern practice suggests that 11 to 13 inches is appropriate for the 105-inch diameter. Such a thickness generates a mirror of only three and a half tons to handle, also one which is not too thick to be relatively easily fabricated and supported; furthermore, in terms of fused silica, the thinner mirror is relatively economical to order since the price of fused silica mirrors rises linearly with weight.

3. As an alternative, we investigated the possibility of grinding away much of the material of the 105-inch Duran 50 blank, and even seriously looked into the question of slicing it in two (as a layer cake) thereby generating two 105-inch blanks, one of which might be used in the coude room. But we were strongly cautioned against this by the Schott engineers and by our consulting optical specialist Texereau, on the grounds of a very serious possibility of its breaking as a result of release of annealing strains by the cutting; or if the blank did not break, it would probably prove exceedingly difficult to finish satisfactorily a mirror with such unusual strain and glass phase-composition patterns as would be relieved and revealed by such cutting into the center of the blank.

For the above reasons, after a number of weeks we reluctantly decided to abandon the idea of using the 105-inch Schott blank. But by this time, the parallel 105-inch designs had been carried forward to the point outlined above. Discussions with manufacturers had indicated that a rise from 84- to 105-inch did not involve major additional difficulties in fabrication and thus would not have the effect of putting us into a different order of magnitude of cost or delivery time. Specifically, it appeared that the actual fabrication of the telescope in this 30% larger size should take about 18 to 20 months, as opposed to an estimated 15 to 18 months for the smaller, and the cost differential should be in the range of a half million dollars. On the other hand, the advantages of the large telescope were clear, in that it would be able to work on objects nearly twice as faint or on a given object in about half the time of the smaller instrument. Also, it would be distinctly advantageous to have available a choice of telescopes at McDonald, in the sense that the 82-inch would be able to carry out problems requiring less over-all light gathering power, reserving the 105-inch for work on objects relatively inaccessible to the 82-inch or for faster and better work on critical problems such as planetary spectroscopy.

With the above arguments in mind, the University Administration and Regents, and the NASA Scientific and Contract Offices were approached with this possibility. A formal request was made in December, near the end of this quarterly report period, for permission to modify the contract to specify the construction of a 105-inch rather than an 84-inch telescope, and to increase the estimated telescope costs by half a million dollars.

D. Ordering of Primary Mirror Blank

If past experience is any guide, the item of longest lead-time in such a substantial telescope project is the procurement and finishing of the primary mirror. Accordingly, we have placed highest priority on the discussion of the size and material of the primary mirror, and the placing of an order for the mirror blank.

As indicated above, the desired performance strongly favored use of fused silica for the mirror, this decision being in harmony with that arrived at by all the major telescope planning groups in the world today (metal mirrors, or extremely thin Pyrex mirrors, or new forms of glass with near-zero coefficient of expansion, all represent attractive possibilities for the future, but in view of the requirement of conventionality imposed on this telescope by its short time scale and budgetary limitations, these possibilities could not be seriously considered).

Only two fabricators of large fused-silica optical blanks are at present able to promise satisfactory and early delivery, namely Corning and General Electric. Their processes are radically different. Corning condenses fused silica from the vapor state, in great furnaces, making large homogeneous pancakes of silica which can be then cut into appropriate segments and annealed together to form blanks of any desired shape and size up to about 110 inches, their largest present oven. The General Electric process melts quartz into relatively small hexagonal billets which are then tiled together to generate blanks of any desired shape and size. For a 105-inch mirror, the Corning process would require a hexagonal tiling of seven segments, three deep, for a total of 21 initial elements; the General Electric process, using material of much lower uniformity and purity, would require about 600 of the small billets, in two layers. We tested samples of the products of both companies, arriving at conclusions identical with those of the Kitt Peak group, to the effect that both materials were satisfactory, the Corning one probably inherently a bit more so.

Specifications were written for a 106-inch blank (suitable for finishing to 105-inch optical surface), 11-1/2 inches thick, back and edges finished, Cassegrain hole cored, and surface sagged or rough ground to within half an inch of the final curvature. Bids were solicited from G. E. and Corning. The Corning bid was triflingly lower in cost than the G. E., and the promised delivery time was one month shorter. In view of what we believe to be the inherent superiority of the Corning process, all the factors indicated that the contract should be awarded to Corning, with eight months delivery promised after the contract signing. (Unfortunately, difficulties of a business rather than a technical nature have prevented early signing of the contract, and may have a significant effect in delaying completion of the telescope)

E. Personnel Connected with the Contract

To administer and carry out the design, construction and bringing into operation of the telescope and its auxiliary instruments, we must build an adequate staff and engineering group. During this report-quarter, the full or part-time employees under the contract included:

1. J. Texereau — optical consultant (also paid much of this time by the Coude Contract NASr-230), during the time prior to and through this grant period completed his work in refiguring the 82-inch McDonald optics, aided enormously in the mechanical and optical design work for the new telescope and in the testing and selection for the primary mirror. (He returned to France at the close of this reporting period)

2. Charles Seeger — one of the best of radio astronomy engineers, has become much interested in problems of applying to optical telescopes

the parameters of design, control, and data read-out developed by radio astronomers for their needs. Since radio astronomers are probably about a decade ahead of most optical astronomers in this area, it seemed quite desirable that one of the senior engineers and scientists associated with the 105-inch project should be such a man as Seeger.

3. Douglas Bynum — design engineering, to assist Floyd.

4. Charles Thompson — engineering and drafting.

5. Jack Sedwick — layout and drafting.

6. Catherine Cornbleth — secretary.

In addition, as commented on in appropriate places above, a number of the staff on The University of Texas payroll have spent proportions of their time ranging from a few to over 50% on the telescope project. Apart from the Project Director, these include Drs. Tull, de Vaucouleurs, Edmonds and Deeming, J. Floyd, M. Krebs, E. B. Hudepohl, J. Starkey, and P. Kirkpatrick.

F. Financial Report

NASA Form 1030 (2-64) for this contract is submitted quarterly by the Auditor's Office of The University of Texas.

G. Illustrative Appendices

A small but representative sample of the many preliminary design drawings and sketches serves to indicate the nature of some of the rejected configurations and the gradual evolution of the more final and detailed concept.

1. Print 660E1 - Early version of 2-pier, cross-axis design, with horizontal coude and 3-floor dome.

2. Print 660E10 - Rejected configuration including eccentric polar axis counterweight.

3. Print 660E13 - Rejected 85-inch configuration also including cylindrical polar axis.

4. Print 660E14 - Rejected 85-inch fork configuration, including 5-mirror coude.

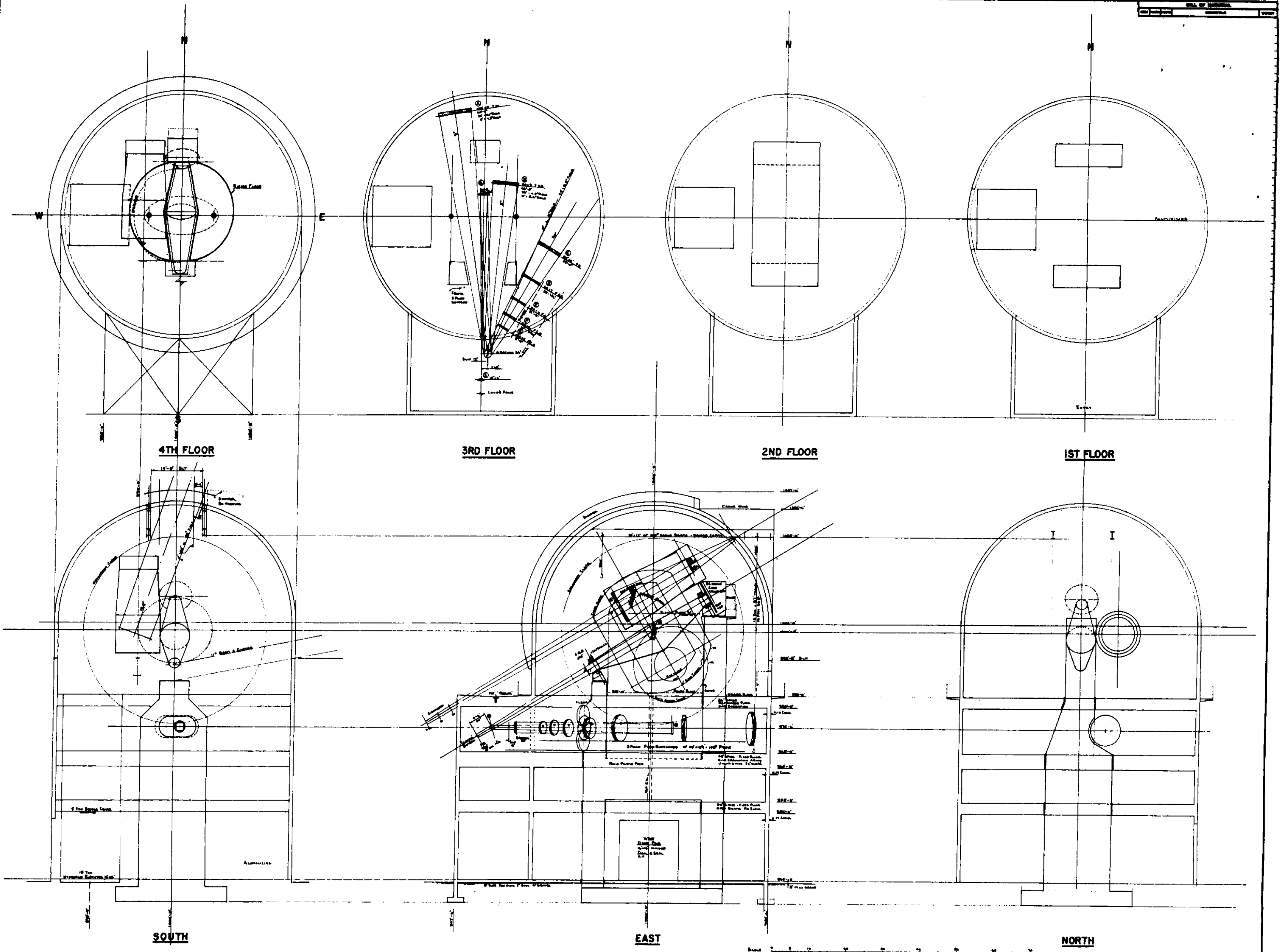
5. Print 660E15 - Rejected 106-inch configuration with eccentric counterweight and square tube.

6. Print 660E16 - First approximation to accepted design, including biconical eccentric polar axis, centered counterweight, cylindrical tube, drive on N pier.

7. Print W660E16 - First rough calculation of weights and moments for provisionally acceptable configuration.

8. Print 660E17 - Rough siting and dome layout.

9. Print 660E19 - Early intermediate version of provisionally acceptable configuration of 105-inch design.

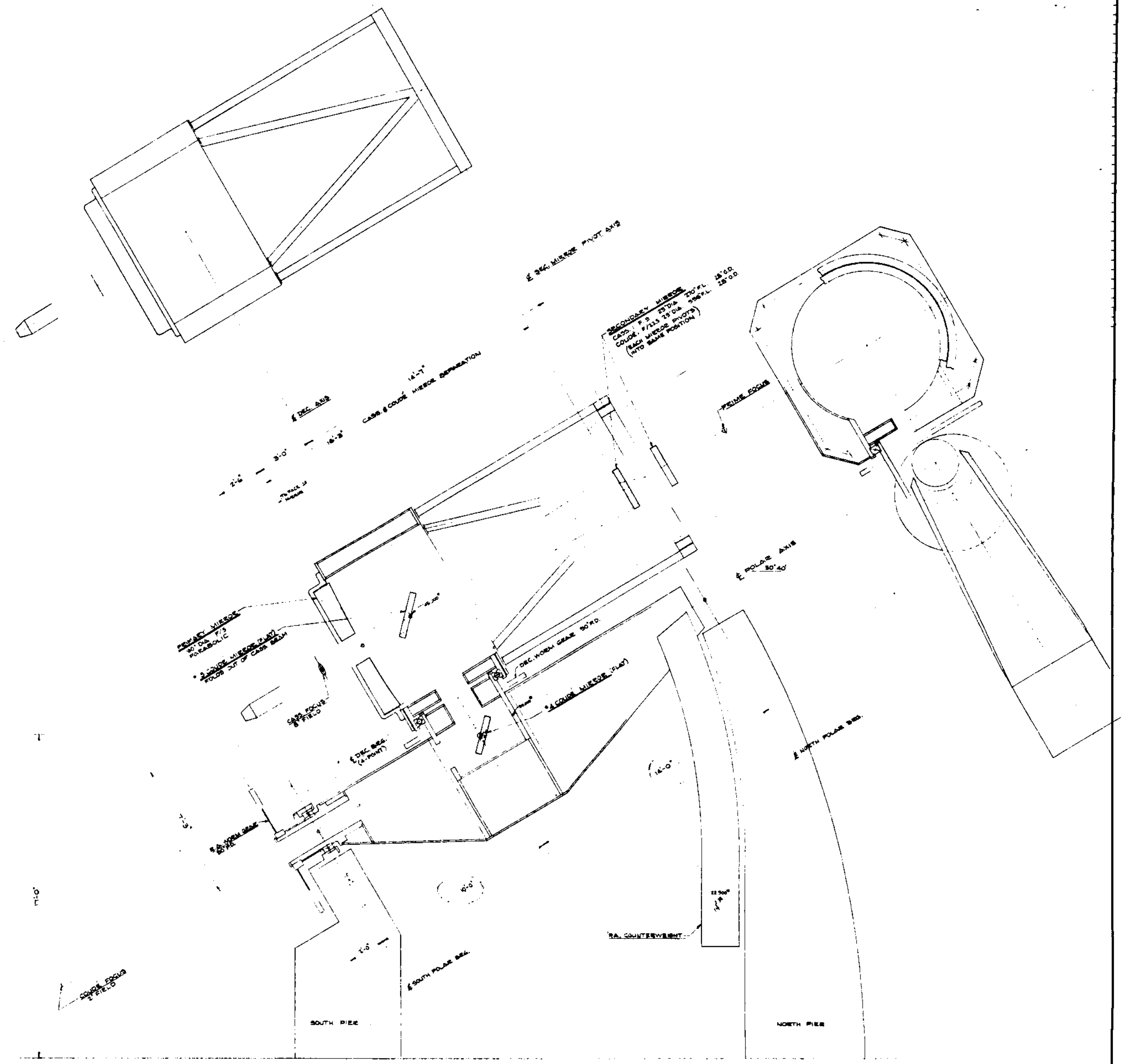


Stellar Observatory - University of Texas - McDonald Observatory

108" Cross Axis with Coudé Design Arrangement.

CHARLES W. JONES ENGINEERING LOS ANGELES CALIFORNIA

660E1



BILL OF MATERIAL

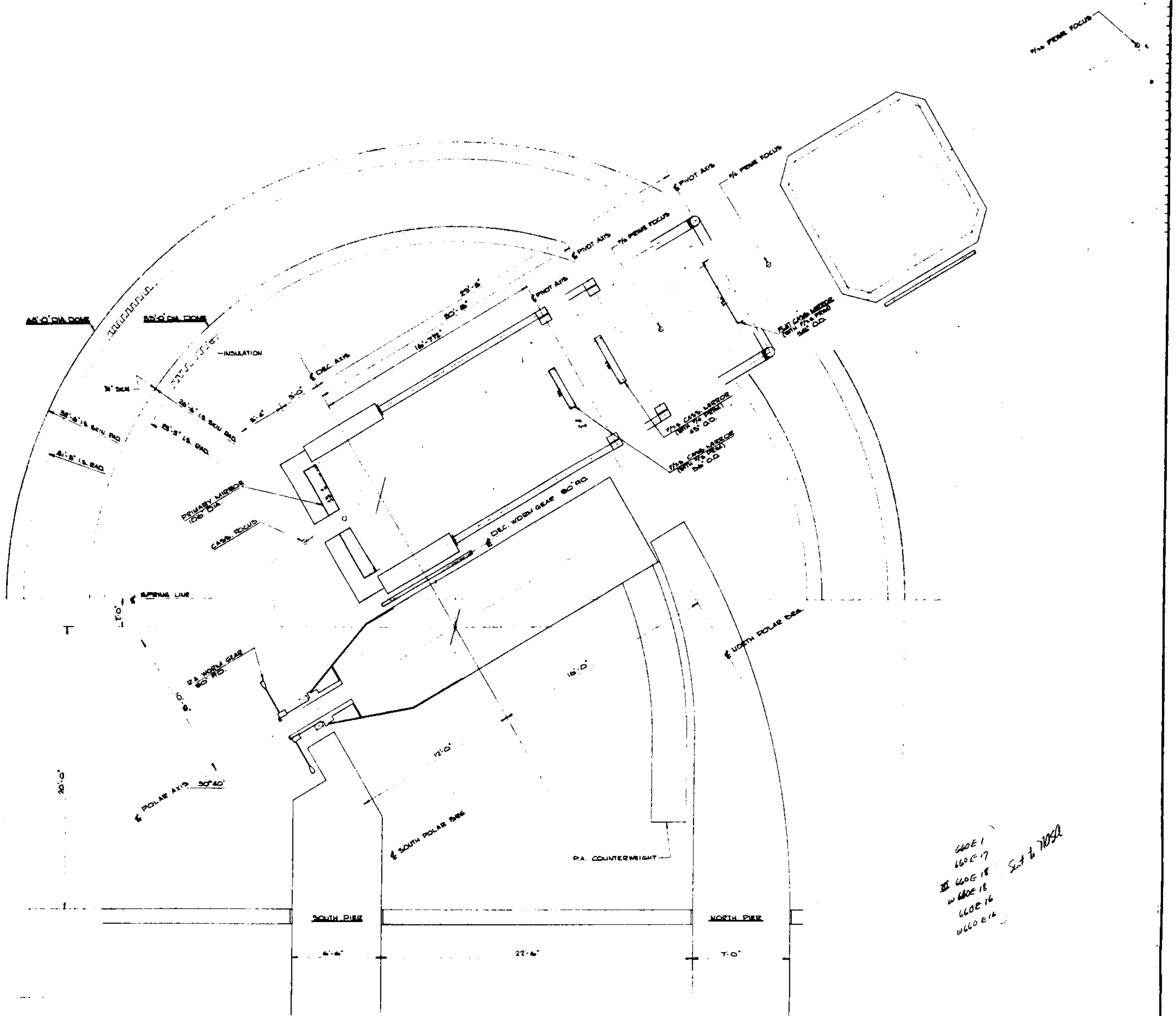
30" CASS.-COUDÉ TELESCOPE -- CROSS AXIS-DBL PIER

GENERAL ASSEMBLY № 1

DATE 12 SEPT 64

CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA

660E 10



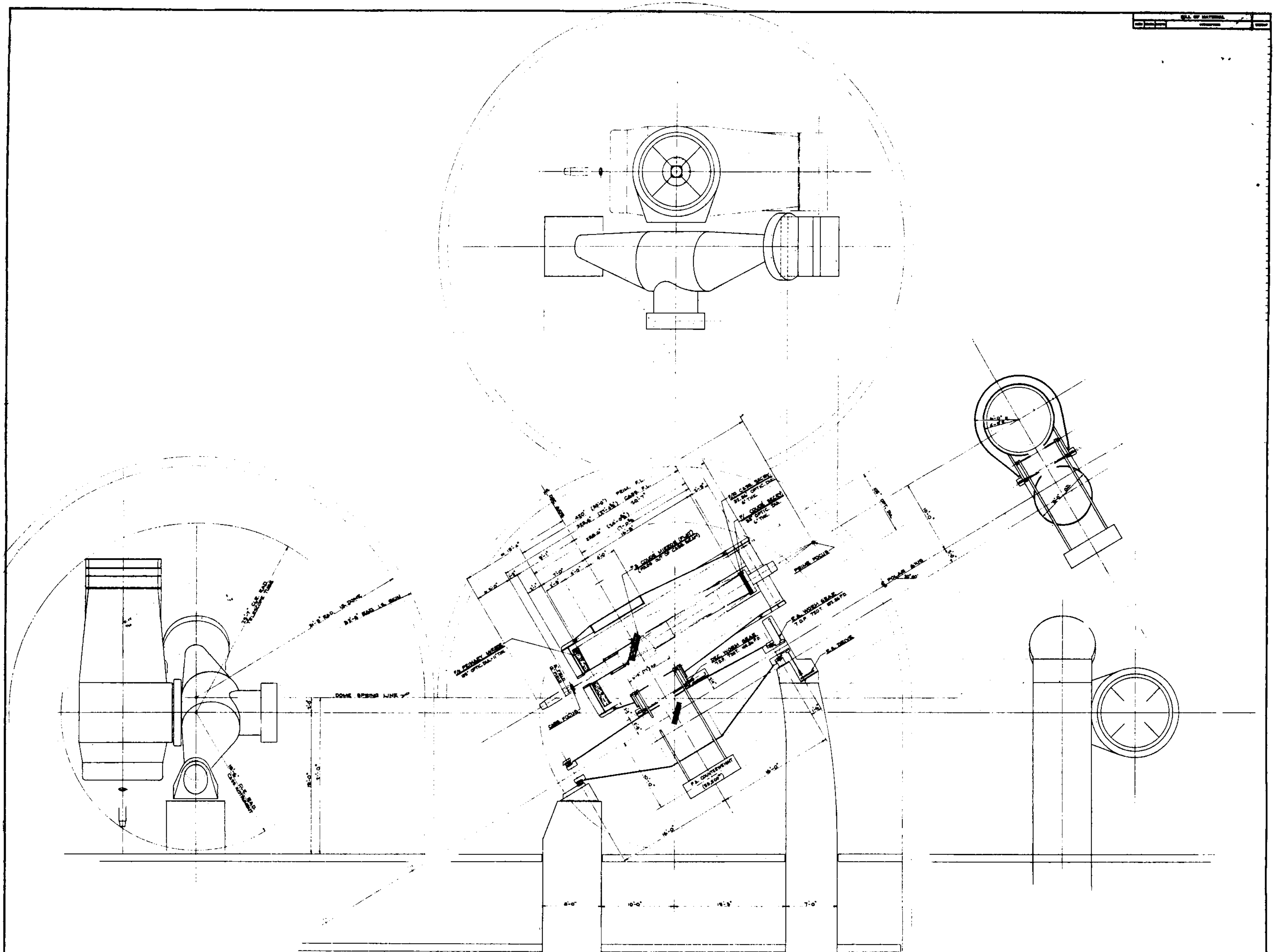
660 E 1
660 E 17
II 660 E 18
W 660 E 18
660 E 16
W 660 E 16
Sent to NASA

DATA	DATA	REFERENCE DWGS.	MARK	REVISION	DATE	BY	CERTIFICATION	APPROVAL
							DATE ISSUED: CERTIFIED FOR:	

106" Cass. – Coudé Telescope – Cross Axis – Del. Pier
General Assembly No 1

CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA

660 E 15



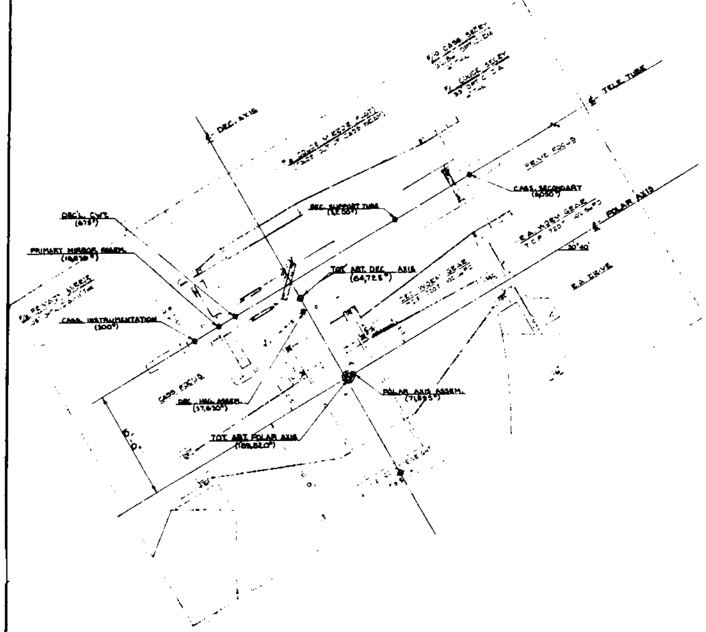
105" OPTICAL TELESCOPE --- CROSS AXIS DOUBLE PIER	
F/4 PRIM. F/10 CASS. F/ COUDÉ --- GEN. ASSEM.	
CHARLES W. JONES ENGINEERING LOS ANGELES CALIFORNIA	660E16

DESCRIPTION	WEIGHT (LBS.)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
CASS. SECONDARY					
MIRROR	540	207.6	120	112,100	64,800
MIRROR CELL	560	213.6	120	119,630	67,200
FOCUS UNIT	1,200	233	120	279,600	144,000
FOCUS UNIT DRIVE	100	257	120	25,700	12,000
MIRROR CELL CWT.	600	269	120	161,400	72,000
SUPPORT FINS	380	233	120	88,540	45,600
SUPPORT RING	2,670	223.5	120	596,745	320,400
CASS SECONDARY SUB TOTAL -	6,050	228.7	120	1,383,715	726,000
COUDÉ SECONDARY					
MIRROR					
MIRROR CELL					
FOCUS UNIT					
FOCUS UNIT DRIVE					
MIRROR CELL CWT.					
SUPPORT FINS					
SUPPORT RING.					
COUDÉ SECONDARY SUB TOTAL -					
NEWTONIAN SECONDARY					
MIRROR					
MIRROR CELL					
FOCUS UNIT					
FOCUS UNIT DRIVE					
MIRROR CELL CWT.					
SUPPORT FINS					
SUPPORT RING					
NEWTONIAN SECONDARY SUB TOTAL -					
SECONDARY SUPPORT TUBE					
SEC'RY SUPPORT TUBE	3,200	125.4	120	401,280	384,000
SECONDARY SUPPORT TUBE SUB TOTAL -	3,200	133	120	426,300	384,000

DESCRIPTION	WEIGHT (LBS)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
CASS. INSTRUMENTATION					
CASS. INSTRUMENTATION	300	-124	120	-37,200	36,000
CASS. INSTRUMENTATION SUB TOTAL -	300	-124	120	-37,200	36,000
PRIMARY MIRROR ASSEM.					
PRIMARY MIRROR	7,400	-89	120	-658,600	888,000
PRIMARY MIRROR CELL	7,670	-95	120	-728,650	920,400
BACK SUPPORTS	1,200	-96	120	-115,200	144,000
BACK DEFINING UNITS					
RADIAL DEFINING UNITS	300	-89	120	-26,750	36,000
INSTRUMENT MOUNT. R.	300	-110	120	-33,000	36,000
PRIMARY MIRROR ASSEM. SUB TOTAL -	16,870	-92.7	120	-1562,200	2,024,400
DEC. HOUSING ASSEM.					
DEC. HOUSING	34,030	-2.85	85.0	-97,080	2,893,500
#3 MIRROR ASSEM.	2,200	-29.5	124	-64,920	272,800
CAMERAS					
DEC. WORM GEAR	1,400	0	44.5	0	62,300
DEC HOUSING ASSEM. SUB TOTAL -	37,630	-4.3	86	-162,000	3,228,600
DEC. CWT. (CASS. TELESCOPE)					
DEC. CWT.	675	-72	120	-48,615	81,000
DEC. CWT. (CASS. TELESCOPE) SUB TOTAL -	675	-72	120	-48,615	81,000
DEC. CWT. (COUDÉ TELESCOPE)					
DEC. CWT.					
DEC. CWT. (COUDÉ TELESCOPE) SUB TOTAL -					

DESCRIPTION	WEIGHT (LBS.)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
DEC. CWT. (NEWTONIAN)					
DEC. CWT.					
DEC. CWT. (NEWTONIAN) SUB TOTAL -					
POLAR AXIS ASSEM.					
(PARTS ROTATING ABOUT POLAR AXIS)					
POLAR SHAFT (WITH BRG. INTER RACES)	65,845	1.08	-2.5	71,275	-163,775
R. A. GEAR	2,460	210	0	516,600	0
#4 MIRROR ASSEM.	1,090	4	-4	4,360	-4,360
DEC. DRIVE	700	31	60	21,700	42,000
DEC. GEAR GUARD	100	0	31	0	3,100
DEC. BEARINGS (INTER RACE)	1,400	0	44.5	0	62,300
POLAR AXIS ASSEM. SUB TOTAL -	71,595	8.6	-.85	613,935	-60,735
POLAR AXIS CWT. (CASS)					
CWT. BLOCK					
VARIABLE CWT.					
TRIM CWT.					
POLAR AXIS CWT. (CASS) SUB TOTAL -	53,500	0	-120	0	-6,419,265
POLAR AXIS CWT. (COUDÉ)					
CWT. BLOCK					
VARIABLE CWT.					
TRIM CWT.					
POLAR AXIS CWT. (COUDÉ) SUB TOTAL -					

DESCRIPTION	WEIGHT (LBS.)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
POLAR AXIS CWT. (NEWTONIAN)					
CWT. BLOCK					
VARIABLE CWT.					
TRIM CWT.					
POLAR AXIS CWT. (NEWTONIAN) SUB TOTAL -					
SOUTH PEDESTAL ASSEM.					
SOUTH PEDESTAL					
SO. PEDESTAL BRG. HOUSING (W. SO. BRG. OUTER RACE)					
SOUTH PEDESTAL ASSEM. SUB TOTAL					
NORTH PEDESTAL ASSEM.					
NORTH PEDESTAL					
R.A. DRIVE					
R.A. GEAR GUARD					
NO. PEDESTAL BRG. HOUSING (W. NO. BRG. OUTER RACE)					
NORTH PEDESTAL ASSEM. SUB TOTAL -					



CASS. TELESCOPE-SUMMARY

DESCRIPTION	WEIGHT (LBS.)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
CASS. TELESCOPE					
CASS. SECONDARY	6,050	228.7	120	1,383,715	726,000
SEC'RY SUPPORT TUBE	3,200	133	120	426,300	384,000
CASS. INSTRUMENTATION	300	-124	120	-37,200	36,000
PRIMARY MIRROR ASSEM.	16,870	-92.7	120	-1,562,200	2,024,400
DEC. HOUSING ASSEM.	37,630	-4.3	86	-162,000	3,228,600
DEC. COUNTERWEIGHT	675	-72	120	-48,615	81,000
TOTAL ABT. DEC. AXIS	64,725	0	100	0	6,480,000
POLAR AXIS ASSEM.	71,595	8.6	-0.85	613,935	-60,735
SUB TOTAL	136,320	4.5	47.2	613,935	6,419,265
POLAR AXIS CWT.	53,500	0	-120	0	-6,419,265
TOTAL ABT. POLAR AXIS	189,820	3.25	0	613,935	0
SOUTH PEDESTAL ASSEM.					
NORTH PEDESTAL ASSEM.					
TOTAL TELESCOPE					

COUDE TELESCOPE-SUMMARY

DESCRIPTION	WEIGHT (LBS.)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
COUDE TELESCOPE					
COUDE SECONDARY					
SEC'RY SUPPORT TUBE					
PRIMARY MIRROR ASSEM.					
DEC. HOUSING					
COUDE COUNTERWEIGHT					
TOTAL ABT. DEC. AXIS					
POLAR AXIS ASSEM.					
SUB TOTAL					
POLAR AXIS CWT.					
TOTAL ABT. POLAR AXIS					
SOUTH PEDESTAL ASSEM.					
NORTH PEDESTAL ASSEM.					
TOTAL TELESCOPE					

NEWTONIAN TELESCOPE-SUMMARY

DESCRIPTION	WEIGHT (LBS.)	DIST. TO DEC. AXIS (IN.)	DIST. TO POLAR AXIS (IN.)	MOMENT ABT. DEC. AXIS (IN. LBS.)	MOMENT ABT. POLAR AXIS (IN. LBS.)
NEWTONIAN TELESCOPE					
NEWTONIAN SECONDARY					
SEC'RY SUPPORT TUBE					
PRIMARY MIRROR ASSEM.					
DEC. HOUSING					
NEWTONIAN CWT.					
TOTAL ABT. DEC. AXIS					
POLAR AXIS ASSEM.					
SUB TOTAL					
POLAR AXIS CWT.					
TOTAL ABT. POLAR AXIS					
SOUTH PEDESTAL ASSEM.					
NORTH PEDESTAL ASSEM.					
TOTAL TELESCOPE					

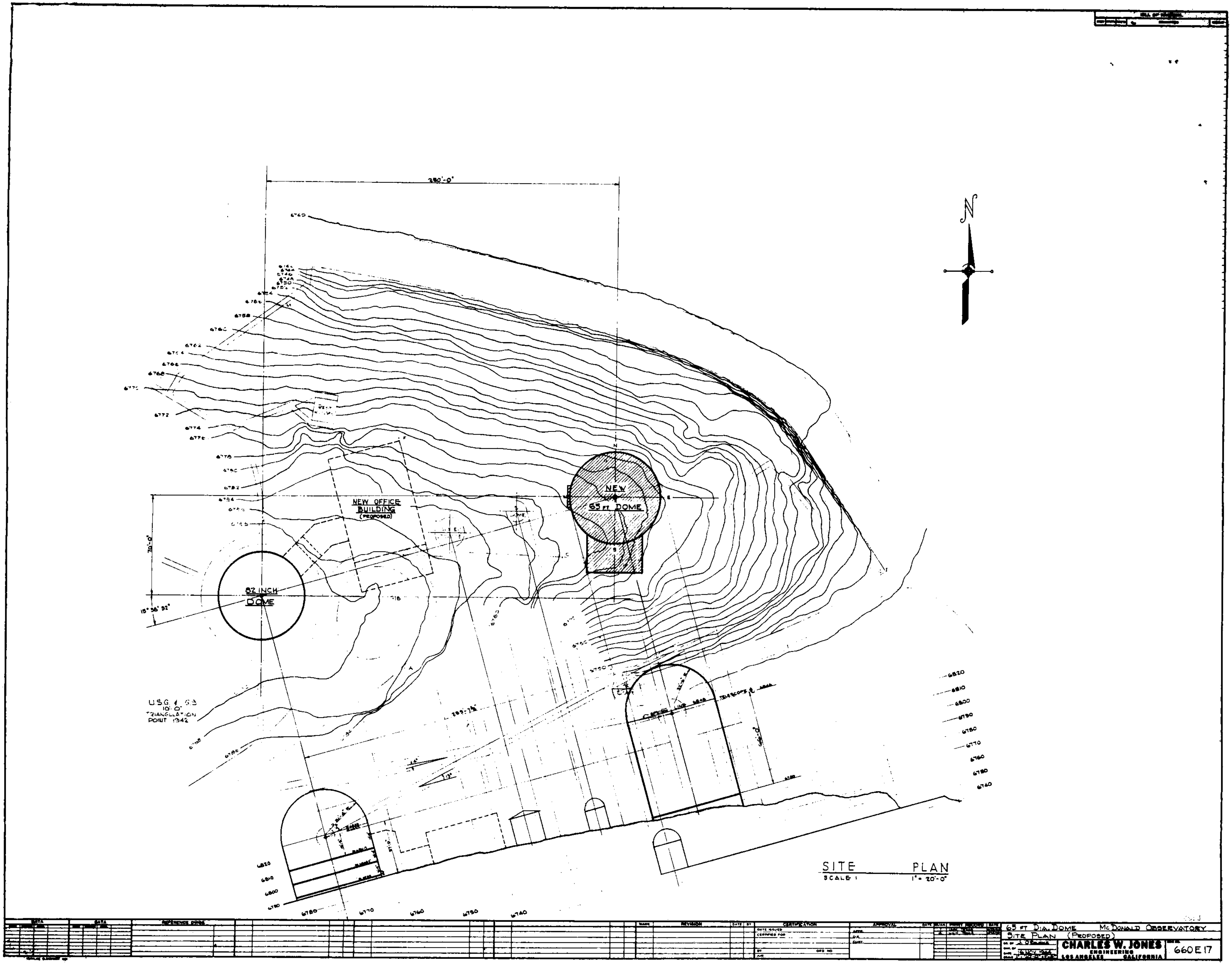
NOTE:
USE THIS DRAWING FOR WEIGHTS ONLY

BILL OF MATERIAL

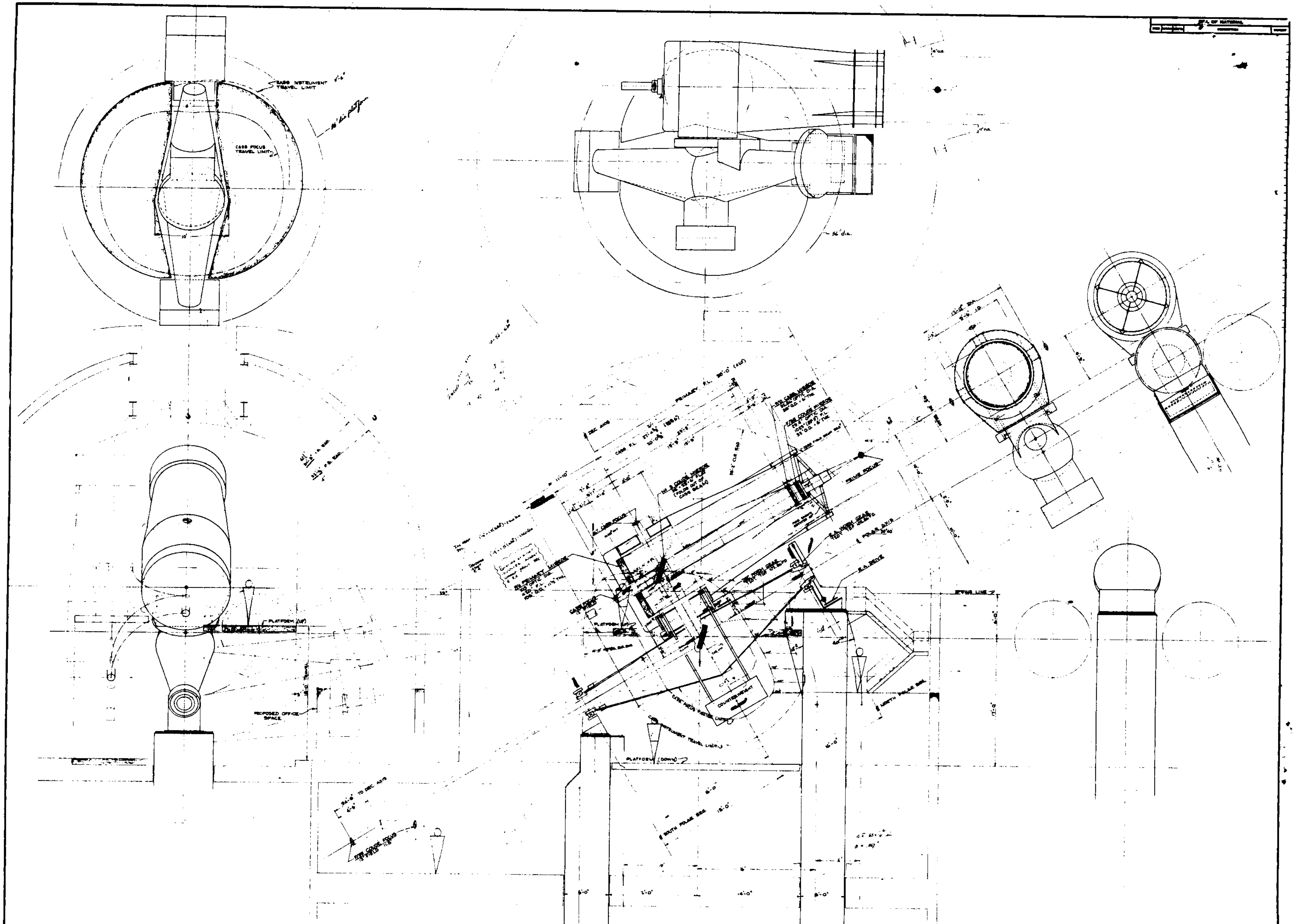
105" OPTICAL TELESCOPE -- CROSS AXIS DBL. PIER
WEIGHT SHEET F/4 PRIM. F/10 CASS.

CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA

W660E16



280'-0"
N
NEW
65 FT DOME
NEW OFFICE BUILDING
(PROPOSED)
70'-0"
82 INCH DOME
15° 36' 32"
USG ⊕ 63
10'-0"
TRIANGULATION POINT 1942
66'-0"
SITE PLAN
SCALE: 1" = 20'-0"
65 FT DIA. DOME McDONALD OBSERVATORY
SITE PLAN (PROPOSED)
CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA
660E17



PRELIMINARY
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105" OPTICAL TELESCOPE -- CROSS AXIS
F/4 PRIMARY F/10 CASS. F/35 COUDÉ GENERAL ASSEM

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